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ABSTRACT

Neural network based intelligent tools, developed for the national security infrastructure, will soon be available for teachers. Neural network software establishes powerful intuitive connections among words, concepts, documents, and search queries. In the school setting, such a search tool could automatically index textbooks, cross-reference any two sets of standards (e.g, district curriculum and state-mandated tests), and identify videos, library books, Internet sites, and instructional software. Neural network technology can be useful in curriculum alignment, which currently is done either manually or with the help of database engines. Two applications of neural network technology include the VITAL Lesson Planner for teachers and the VITAL ResourceMiner for district level curriculum specialists. These tools allow individuals to utilize and manage volumes of state frameworks, state and standardized test objectives, and instructional resources, with speed and power. There are many possible applications of these tools: states can use them during textbook adoption to independently corroborate the fit of a textbook series to the state's framework; districts can align local curriculum and content standards and benchmarks to state and national standards; schools can verify and adjust instructional coverage to match state mandated tests; and teachers can develop thematic cross-curricular lesson plans. (SM)

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Smarter Tools, Better Teachers:

Applying Neural Network Technology to Curriculum Alignment

by

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This paper describes applications developed for Jostens Learning Corporation by Aptex Software, Inc. using proprietary neural network software technology developed by Aptex Software's parent, HNC Software, Inc.

Neural-network based intelligent tools, developed at great expense for our national security infrastructure, are now being used commercially in applications like consumer credit protection and the indexing of large volumes of information on the Internet. Soon, the first wave of neural network based intelligent tools will be on teachers' desktops.

Overview

Neural network software establishes intuitive connections among words, concepts, documents and search queries in a way that is far more powerful than less sophisticated keyword searching. The technology was developed to automate the indexing of written documents, especially newspaper articles, in support of national security efforts. Limitations in manual indexing include cost, time, and the inability of editors to cross-reference every possible request for information. This software overcomes these limitations, and now it is being applied in ways that can help schools overcome their own data-management challenges.

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Jostens Learning Corporation saw the potential of this cutting edge technology and the many benefits it could hold for education. Many factors were considered, including educational trends (especially Goals 2000 and standards-based curriculum reform), the literature on school systemic change, field observations and reports from more than 6,000 Jostens Learning school sites, as well as the existing successful commercial applications of this software technology.

In the school setting, such a search tool could automatically index textbooks, so that a teacher could easily find specific pages in a text that support her current lesson. It could be used to cross-reference any two sets of standards, like a district curriculum and a state-mandated test, in order to verify that the district curriculum meets state test requirements. It could even be used to identify videos, library books, Internet sites, and instructional software so that a library media specialist could rapidly create resource-based lessons that directly supports a teacher's thematic unit. Which of these, or many other choices, would be the best application of this software?

The Problem

The curriculum is critically important because it defines what will be taught. However, in any classroom, there are many curricula, which can result in lots of confusion. The approved district curriculum is there. So are national standards. Textbooks also serve as a curriculum. For example, a recent large national survey reported that despite district requirements, 84 percent of elementary teachers use the textbook as their main mathematics curriculum resource and of these, 40 percent follow the instructional sequence in the book very closely (Educational Marketing Research, 1996). The objectives included in mandated tests also represent a very real curriculum. Often these curricula compete against each other, creating a counterproductive situation.

The Association for Supervision and Curriculum Development has identified this problem, and has called for a concerted effort for schools to align their curriculum to state and national standards in order to obtain more consistent student achievement. Adding

fuel to the fire, Goals 2000 requirements are driving administrators and teachers to demonstrate that district and classroom curricula meet state mandates and required state assessments, often with associated rewards or reproofs.

Norma Webb (1997), head of the Strategies for Evaluating Systemic Reform project of the National Institute for Science Education says that alignment between expectation expressed as state and national standards documents and assessments is difficult for several reasons. First, expectations and assessments tend to be "expressed in several pieces or documents, making it difficult to assemble a complete picture." It also is "difficult to establish a common language for describing different elements of policy . . . The same term may have different meanings when used to describe something measured by assessment." Third, a constantly changing policy environment can lead to confusion, as "new goals can be mandated . . . while old forms of assessment are still in place."

It is inevitable that such requirements and mandates increase workloads for teachers, district administrators, and even state administrators in terms of curriculum development and paper work. But there are only so many hours in a day. Hargreaves (1997) notes: "Change strategies that are preoccupied with standards, targets, checklists, and form-filling can leave teachers with no time to care for or connect with their students. When this happens, teachers feel that their fundamental purposes have been lost - with catastrophic results for their commitment and effectiveness." (1997 ASCD Yearbook). Indeed, time is the most precious commodity in the classroom.

Current Solutions

There are two general ways that curriculum alignment occurs now, either manually or technology-assisted. Manually, teachers and curriculum specialists and costly outside consultants can spend literally years poring over standards, frameworks, test objectives, textbooks, and resources and link these by force of will. In a technology-assisted approach, the same individuals utilize flat or relational database engines containing these

materials to accomplish the same task, but with some time savings. However, current technology-assisted alignment represents only an incremental gain in efficiency and at a relatively high cost.

Unfortunately there are weaknesses in both methods. First and foremost, a large block of costly staff time must be allocated to the project. Huge amounts of educational materials must be gathered and organized. Even with the time-saving technology-assisted approach, materials must be converted into an electronic form, then entered into a database. And with both methods, the inevitability of human error results in overlooked, misapplied, or mismatched links to resources.

Further, materials constantly change. For example, most textbooks adoptions are on a five- or six-year cycle. When the new textbook arrives, the alignment process begins anew. Also, standard database searching requires that teachers understand not only how to use the software but also how the data must be queried. The documents involved have been developed by different groups using different approaches and different vocabulary. Teachers must be taught to "speak" the language of the multitude of different documents in the database - an added difficulty and training burden schools don't need.

A Better Way

Clearly a better method was required. Neural network software technology could be used as the core of an intelligent tool to overcome many of these problems. For such a tool to be successful, instructional materials must be preloaded into the system, with automatic updates as materials change. Also, any additional customized materials, like exemplary lesson plans, should be able to be entered into the system at a low cost. It must be easy to learn and easy to use. The search engine technology in the tool must be able to read and interrelate large numbers of diverse documents without the need to pre-categorize or homogenize the documents. It must be so easy to use that it is intuitive, that it "looks" like teachers expect it to look and "thinks" the way teachers think, so that teachers will use it.

Most importantly, an intelligent tool (or any classroom-based intervention) must take on the "grunt" work and allow teachers to do what they do best. Rothman (1996) says: "As states and districts move to develop standards for student performance, educators are realizing that the hard work lies ahead. As difficult (and important) as it may be to agree on what students should know and be able to do, perhaps the bigger job is changing instruction to ensure that students can attain the standards."

Educational Leadership

Charlotte Danielson (1996) says: "When teachers are knowledgeable about the range of resources to aid in their teaching, they can expand their repertoire of instructional goals, knowing that they can go to these resources for help. Awareness of these resources is the first step in using them in a classroom." She goes on to say: "Knowledge of resources to assist students is part of all teachers' responsibility. Students' full potential can only be realized if their teachers are aware of what is available."

Teachers need to know what's available to them in the classroom, where the real work of education is done. An intelligent tool should be placed directly into teachers' hands, should be very easy to use, and must save the teacher time.

JLC determined that initially two applications of neural network technology were needed, one for teachers (VITAL Lesson Planner) and a second for district level curriculum specialists (VITAL ResourceMiner). These tools would allow teachers and district-level educators to utilize and manage volumes of state frameworks, state and standardized test objectives, and instructional resources like textbooks and instructional software, with ease, quickness and power. Follow-up discussions with educators indicated that these intelligent tools are the right software at the right time.

How the Technology Works

The system is set up by JLC and Aptex. Setup involves "training" the system to establish a table of semantic relationships and loading documents into the system using these relationships. Using a library as an analogy, the first step, training the system, is like creating a method to shelve sets of similar documents based on the specific content of the documents. Loading the data set is like putting the documents on the shelves. To further explain the workings of VITAL ResourceMiner and lesson Planner, here is a brief description behind the scenes:

The system uses mathematical models to create relationships between words. Educational materials are scanned into the system, and every word is given a relative position to every other word. This relationship continues to shift and change as more material is read into the system. After about 20,000 related documents have been read, the associations between words becomes fairly well established. At that point, the data set is a complex mathematical system, however it is possible to represent this system visually (see Figure 1).

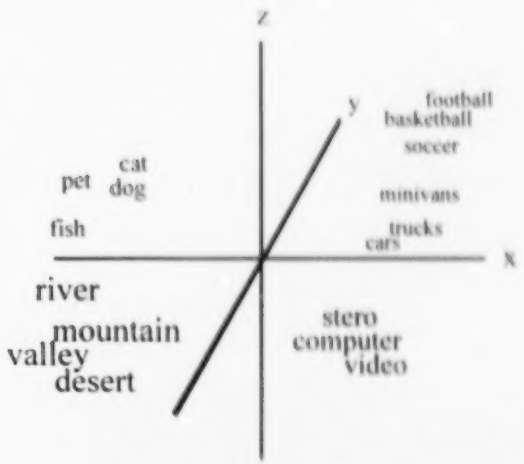

Figure 1. A sample visual representation of word relationships established by neural network software.

Words that occur together in context also are "near" each other in the system. Words like basketball and football would be "nearer" or more associated than say football and cat. A word like fish would be associated both with pet and river. In reality, the words exist in tables, and the word associations are represented by mathematical relations called vectors. This is the heart of the system and what makes these tools unique and powerful.

A large set of documents is then entered into the system to create a structured data set. The documents in this universal data set include test objectives from standardized tests, major textbook indexes, state and national frameworks and tests, nearly all JLC lesson/activities, and other sources. A district can add additional unique documents.

How does the software structure this large data set? The system reads a document, like a page, or unit from a textbook, or a description of an instructional videotape. The vectors for every word in the document are averaged together to produce ONE vector for the entire document that points to its location in the data set. Each document is processed in the same way and assigned a vector. Similar documents will be "nearer" to each other (see Figure 2).

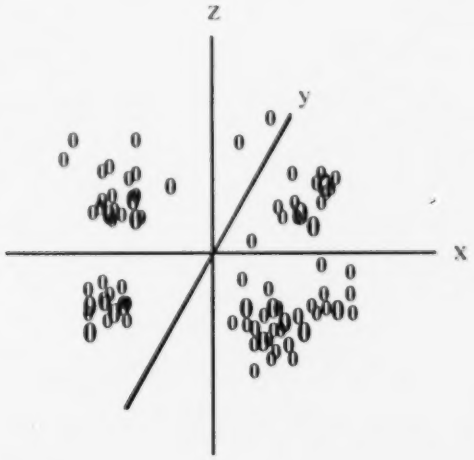

Figure 2. How the organization of the universal data set documents might appear if displayed visually.

In a very real sense, the documents in the data set are grouped together conceptually. When a teacher queries and then identifies a valuable resource to support a lesson plan, such as a hands-on activity, other resources like related textbook pages, supporting instructional software, targeted state test items, and state and district level curriculum benchmarks will be identified also, thus expanding by serendipity the instructional options immediately available to the teacher.

Using ResourceMiner and Lesson Planner

The look and functionality of VITAL Lesson Planner and VITAL ResourceMiner were developed by educators and software design specialists. Only a handful of screens are needed to develop a lesson plan or to create a district correlation document. The terminology and the display are teacher-friendly. The system is fast and very accessible. Also, the intelligence of the system allows teachers to speak to it in natural language. All of these factors combine to make the tools easy to learn and to use.

The system resides on a file server on the Internet or on the school district's Intranet. Teachers access the system by using a standard Internet browser like Netscape. This means the tools are platform-independent (Macintosh or Windows). Further, there are no additional hardware costs if the school already has Internet-capable computers. Also, educators can access the system through an http address with a login and password from home or school, in fact from anywhere on earth.

To do a search (or query), a natural language statement is entered. For example, a teacher may type in, "Find materials on oceanography especially habitats and plants." The system combines every word in the search statement to produce one vector for the statement that "points" to the related documents. The system looks at that "location" and returns all documents "near" that location. Said differently, the system lists all documents that are related to the query statement. Using the library analogy again, having Lesson Planner is like assigning a good librarian to every teacher to immediately identify instructional resources. To display the search results, the system ranks the

documents by relevance to the query statement and displays this list to the teacher (see Figure 3).

	Type	Title	Product	Location	Description
1	ACT	Ocean Plants	BSCS - Gre	page 72	Unit on plants tha
2	RES	The Green Earth	Library boo	Municip	Introduces the vie
3	RES	Biomes of the Earth	JLC Science	SS-010	Biomes are descri
4	RES	The Ocean Desert	VHS - Tape	Media Ce	This video portra
5	ASM	Vocabulary use - science	ITBS	Obj.6.12	Applied word use
6	OBJ	Biomes	Proj 2061	http:\\pro	National science o
7	ACT	General Ecology	BSCS - Gre	page 63	Introduction to ec
8	RES	Stories of the Sea	JLC Literat	RM-704	Uses ecology ter

Figure 3. Sample list of documents from the universal data set ranked by relevance to the query statement.

Notice that the list contains documents from multiple sources including textbook activities (ACT), JLC software (RES), test objectives (ASM), and frameworks (OBJ). The items in the list are ranked by relevance to the search statement. When the teacher selects an item in the list, another window opens that provides more detail about that item. After examining items, the teacher marks the activities to be included, adds the lesson plan to the electronic calendar, e-mails it to the principal, and prints it for classroom use, all from within the application.

What Comes Next?

These first intelligent tools will soon be on educators' desktops. What can they do for educators? Here are several immediate applications.

- They will be used by states during the textbook adoption process to independently corroborate the fit of a textbook series to the state's frameworks, so that districts don't have to depend on the publisher to provide this critical information.

- These capabilities will be used by districts to align local curriculum and content standards and benchmarks to state and national standards.
- They will be used by schools to verify and adjust instructional coverage to match required state mandated tests.
- They will be used by teachers to develop thematic cross-curricular lesson plans.
- They will allow complete and regular integration of software activities into mainstream instruction.

How will VITAL tools impact instruction? Teachers already spend considerable time and effort finding or creating instructional materials. During the lesson planning process, queries like the one above identify exact supporting textbook pages, exact pages from supplementary books and workbooks, related videos from the library, statements of state and district standards, and test items that the lesson will address. This allows teachers to provide richer learning environments that are focused on district and state standards and mandated test objectives, all with less preparation time.

VITAL tools allow teachers to intimately participate in standards-based reform on a daily basis. Research on standards-based approaches describes overall increases in the achievement of all students as well as narrowing the gap between various ethnic and socioeconomic groups (Marzano & Kendall, 1996). Further, using these powerful tools in this way spreads curriculum accountability from the state and district offices all the way into the classroom, where it ultimately will have the greatest result. The role of all levels of the administration then shifts from creating curriculum documents and enforcing mandates, to supporting, mentoring, and bird-dogging teachers as they teach. Ask yourself, "Isn't this the right way to do it?"

All of these applications and more will work together to enhance the instructional process and advance the quality of education for students.

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